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Air-Ocean Modeling and Prediction System Development

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LONG-TERM GOAL

Increase our scientific understanding of the processes that are responsible for energy transport between the atmosphere and ocean and apply this knowledge to improve our ability to predict the atmosphere and ocean, particularly in their respective boundary layers.

OBJECTIVES

Study the effects and feedbacks that occur on the mesoscale between the atmosphere and ocean. For example, strong winds that form in the lee of orography can have a marked influence on the ocean surface and circulation through ocean surface gravity wave induced stress and enhanced mixing. The wave-induced stress can have an important feedback to the atmospheric boundary layer structure through the modulation of the momentum flux.

APPROACH

Utilize existing atmospheric and ocean wave models such as COAMPS and WAM to study the air-sea interaction processes. COAMPS represents a fully coupled system of atmospheric and ocean models including ocean wave and circulation modeling systems. Tests of these interactive systems will give insight into the problems of interactive air/ocean models, e.g., wave induced stress and feedbacks, and will guide ultimate development of interactive atmosphere/ocean models. .

WORK COMPLETED

Used COAMPS to investigate the potential impact of mesoscale atmospheric jets that form in the lee of steep orography on the ocean circulation dynamics. Continued integration of the WAM into COAMPS. Built interfaces in COAMPS for the full coupling of WAM.

RESULTS

Idealized and real-data numerical model simulations are used to investigate the dynamics of low-level jet streams that form in stratified flow downstream of the vertex of large elliptical barriers such as the southern tip of Greenland, hereafter referred to as "tip jets". The tip jet dynamics are governed by conservation of Bernouli function as parcels accelerate down the pressure gradient during orographic descent. Enhanced surface-based forcing of the ocean circulation occurs in the region of the tip jet core through large air-sea energy exchange (upward surface-heat fluxes > 800 W m^{-2}), and at the tip jet flank through localized extrema of the curl of the surface stress. Additionally, preliminary simulations were

performed with WAM for a tropical cyclone case in preparation for future fully coupled atmosphere/ocean wave tests. The high resolution tests will address questions related to the importance of air-sea coupling due to ocean-wave induced stress.

IMPACT

The idealized and real-data simulations of complex orographic flows in the vicinity of Greenland highlight a new phenomenon that could have a significant impact on the local ocean circulation. Other numerical simulations indicate plumes of vorticity generated in the lee of Cape Adare, Antarctica, are suggestive that tip jet phenomena may be not be confined to Greenland. Future impact of the ocean wave induced stress still needs to be assessed.

TRANSITIONS

Developments from this program will transition to an existing 6.4 program (PE 0603207N) for applications within COAMPS and for possible transition to Fleet Numerical Meteorology and Oceanography Center (FNMOC) for operational use.

RELATED PROJECTS

Related 6.2 projects within PE 0602435N include BE-35-2-18, which focuses on the development of the atmospheric component of COAMPS, and 3523 which focuses on the development of an ocean model for COAMPS. A related 6.4 project within PE 0603207N is X0513-02 which focuses on the transition of COAMPS to FNMOC. Another 6.4 project, within PE 0603785N is 0120-ADV which focuses on the development of a coupled data assimilation system for COAMPS.

PUBLICATIONS

Doyle, J.D., and M.A. Shapiro, 1999: Flow response to large-scale topography: The Greenland tip jet. (Accepted for publication in *Tellus*).